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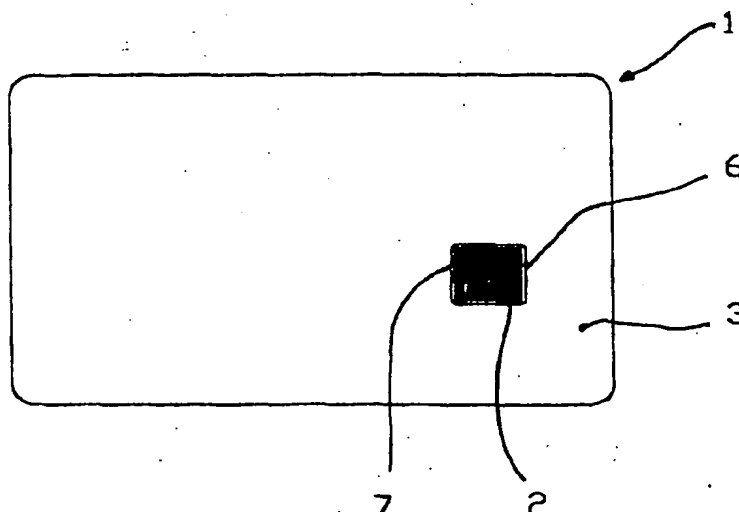
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(57) Abstract

An electronic module (6) suitable for producing contactless cards (1) and/or contactless electronic labels, and comprising a carrier (10) for an electronic microcircuit (7) connectable to an antenna (2) to enable contactless operation of the module (6). The whole of the antenna (2) is arranged on the electronic module (6) and the turns lie in the plane of the carrier substrate (10). Said electronic module (6) is useful for producing contactless cards and electronic labels.

(57) Abrégé

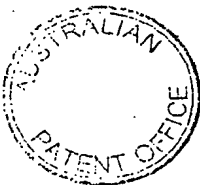
Ce module électronique (6), du type approprié pour la fabrication de cartes (1) sans contact et/ou d'étiquettes électroniques sans contact, et comportant un support (10) pour un microcircuit électronique (7) qui est destiné à être connecté à une antenne (2) de façon à permettre un fonctionnement sans contact du module (6), est caractérisé en ce que l'antenne (2) est toute entière disposée sur le module électronique (6), les spires étant réalisées sur le plan du substrat de support (10). Ce module électronique (6) est utilisé pour fabriquer des cartes sans contact et des étiquettes électroniques.



ABSTRACT  
CONTACTLESS ELECTRONIC MODULE  
FOR A CARD OR LABEL

An electronic module (6) suitable for producing contactless cards (1) and/or contactless electronic labels, and comprising a carrier (10) for an electronic microcircuit (7) connectable to an antenna (2) to  
5 enable contactless operation of the module (6). The whole of the antenna (2) is arranged on the electronic module (6) and the turns lie in the plane of the carrier substrate (10). Said electronic module (6) is  
10 useful for producing contactless cards and electronic labels.

Figure 1



CONTACTLESS ELECTRONIC MODULEFOR A CARD OR LABEL

The present invention relates to the field of portable objects such as, in particular, contactless electronic labels and chip cards provided with an electronic module comprising an integrated  
5 microcircuit.

The invention also relates to a process for manufacturing such modules and such portable objects.

Portable objects are already known in the form of contactless cards, of ISO format, which are intended  
10 to perform various operations such as, for example, payment operations for transport, telephone or other services. These operations are conducted by means of remote coupling between the card's electronic module and a receiver or reader unit. Coupling may be made in  
15 reading mode only or in reading/writing mode.

In respect of cards, it is to be noted that the invention does not only concern cards which operate exclusively without contact. It also relates to mixed or hybrid cards which are able to operate in both  
20 modes : without and with contact. These mixed cards are intended, for example, for operations of electronic cash dispensing type for which, after being charged with units of value (monetary units, payment units for various services) they are remote debited by a certain  
25 number of these units of value when they are passed in the proximity of a reading terminal : this type of debiting assumes contactless operation. If required,



these cards can be re-charged in a purpose-designed dispenser.

For the needs of the present disclosure, and for simplification purposes, contactless cards shall be construed as meaning both mixed cards and contactless cards.

Also portable items are known in the form of electronic labels, generally used for various identification or follow-up operations. They are made up firstly of an electronic module with a microcircuit, and secondly of a carrier for this module associated with a coiled antenna operating at relatively low frequency (150 Khz) and of relatively large size in relation to the size of the module.

Such as they are currently produced, portable objects in the form of electronic labels comprise antennae having a large number of turns, often over 100, and their size makes their handling difficult, especially during the label production stages when the antenna is connected by welding to the module's microcircuit.

Similarly, portable objects in the form of contactless cards also have disadvantages. Such as they are currently produced, contactless cards are portable objects of normalized size. A usual, but in no way restrictive, standard for the present invention is the so-called ISO 7810 standard which corresponds to a card of standard format 85 mm long, 54 mm wide and 0.76 mm thick.



In most known contactless cards, each card comprises a card body made up of an assembly of plastic sheets and of an electronic module, embedded in this assembly, comprising an integrated circuit or microcircuit also called a « chip » connected via two connection terminals to a coiled antenna of self-inductance type. The chip has a memory and may, in some cases, comprise a microprocessor. The size of the electronic module is substantially smaller than the size of the card, the module generally being positioned in one of the corners of the card, since the mechanical stresses exerted on the module through bending of the card are not as high in the corners as in the centre of the card.

In some known contactless cards, however, provision is made in the card body for a cavity, and provision is made for a module fitted with a coil connected to an integrated circuit, to enable contactless operation of the card.

In this category of contactless cards, an assembly unit is particularly known after DE-A-43 11 493 (AMATECH), for the production of identification units in card format.

According to a first embodiment, a module 21 comprises a module carrier 28 on which is fixed an integrated circuit chip 29. A coil 30 surmounts chip 29 in such manner as to confer contactless identification capacity upon the module. This document specifies that the reading distance between the module and the contactless reader is small. Also, to date no chip card using such a module with antenna has apparently been



marketed given the problems of cost and small range which necessarily arise with the described module structure.

Also, it is to be noted that in this document  
5 the antenna is in the form of a coiled air antenna inserted over the chip which gives rise to difficulties relating to production, cost, yield and lack of homogeneous performance.

Also, after DE 37 21 822 C1 (PHILIPS) a chip  
10 card operating without contact is known, whose design is intended to solve a problem of poor connection between the coil and the integrated circuit. For this purpose, this document describes a chip card without a module, an antenna 4 being fabricated on the  
15 semiconductor itself on which an integrated circuit 5 is made. The antenna is made at the same time as the upper tracks of the integrated circuit so that the resulting integrated circuit is 4 x 6 to 6 x 8 mm<sup>2</sup> carrying 20 small turns.

20 As a result the effective surface area of the antenna is small, which is detrimental to its range. Also, the card in accordance with this document cannot be produced in economic manner. It is known that the size of an elementary semiconductor pad is one of the  
25 main cost factors for mass produced integrated circuits. In this document, however, the minimum size of the integrated circuit incorporating the antenna is of about at least 24 mm<sup>2</sup>, whereas cheap contactless cards generally use microcircuits of very small size,  
30 of about 1 mm<sup>2</sup>.



A plurality of other processes for making contactless cards are also known, such as those described in French patent applications made by the same applicant and filed under numbers 95 400305.9, 95 400365.3 and 95 400790.2. These patent applications all describe a contactless card provided with an antenna whose size is substantially the same as that of the card and is connected to a micromodule carrying the chip.

Such antenna has the advantage of having a relatively high range for a given reading or writing magnetic field. The equation which determines the electromotive force  $E$  appearing at the terminals of the receiver antenna when it breaks an electromagnetic field is of the following type :

$$(1) \quad E_r = 1_e (K_e S_e N_e) \cdot (K_r S_r N_r) / D^3$$

in which  $K$  is a constant,  $S$  is the surface area of an average turn of antenna,  $N$  is the number of turns coiled to form the antenna, indices  $e$  and  $r$  represent the emitting and receiver sides respectively, and  $D$  is the reading distance, i.e. the distance between the card antenna and the antenna of the outside reader.

To cause the circuits of the card chip to operate in order to initialize and conduct a reading operation, voltage  $E$  must be exceed a certain threshold, which is generally in the region of 3 Volts.





It will therefore be seen that for a given reading or writing distance D that it is sought to achieve with the contactless card, the surface area of the average turn and/or the number N of antenna turns  
5 needs to be increased on the reading and/or writing side.

The efficiency of the antenna, at the chosen frequency for reading or writing, will be determined by the overvoltage coefficient of the antenna coil which  
10 is given by the equation :

$$(2) \quad Q = L\omega/R$$

in which L is the coil inductance which increases with  
15 coil diameter and the number of turns,  $\omega = 2\pi f$  in which f is the reading frequency which is fixed for a given application, and R is the electric resistance of the antenna coil, which is proportional to the length of wire of which it is formed.

20 Since L and R have contrary effects on the efficiency of the antenna, they tend to offset one another so that the true efficiency factor of the antenna is especially related to the total surface area SN of the antenna.

25 For a given planar coil size, the number N of turns is limited by the width of a turn and the space between two turns which depend upon the technology used for fabrication.



It is therefore seen that, all other things being equal, the natural tendency to obtain a good antenna for a contactless card, which has been widely used in practice, is to use on the contactless card an  
5 antenna in which the size of each turn is as close as possible to the surface of the card. This is why the contactless cards on the market comprise an antenna integrated into the body of the card close to its periphery.

10 But, as experience in the manufacture of such contactless cards has shown, this choice also leads to a certain number of disadvantages.

Handling an antenna of this size for its integration into the card and its electric connection  
15 to the electronic module raises serious technical problems (as in the previously mentioned case of electronic labels).

Despite the techniques used, card and antenna assembly often remain complex and costly since the  
20 electronic module and antenna coil must be connected by means that are difficult to automate. Further, the assembly undergoes lamination which is a costly process requiring the addition of resin to sink the coil and module in the card in such manner that they do not  
25 appear on the surface of the card and do not deform the upper and lower sheets used for colamination.

Also, the complexity of the process does not give yields comparable with those achieved for the manufacture of contact cards. This is especially so  
30 when integrating the restraints required for certain



types of card printing and the possible existence of a magnetic stripe or embossing. For certain types of card printing or to make a magnetic stripe on the card, the latter must have virtually perfect planarity with  
5 defects of less than 6  $\mu\text{m}$ . For embossing, materials need to be chosen which are compatible with the card manufacturing process and the antenna must, in particular, leave free the area provided for embossing otherwise it would be damaged during embossing.

10           Given all these disadvantages connected with current manufacturing methods for contactless cards and electronic labels, which chiefly result in high manufacturing costs, the applicant's engineers set out to determine new processes for manufacturing  
15 contactless cards and labels able to avoid all the above-mentioned disadvantages.

More precisely, a purpose of the present invention is to make available non-expensive means which may be used for the manufacture of portable  
20 objects of chip card and/or electronic label type.

25



According to one aspect of the present invention there is provided an electronic module suitable for producing contactless cards and/or contactless electronic labels, said module including a carrier substrate for an electronic microcircuit, said electronic microcircuit being connectable to an antenna to enable contactless operation of the module, the whole of said antenna being arranged on the module and including turns made in the plane of the carrier substrate, wherein the microcircuit is placed on the same side as said antenna astride its turns, wherein end terminals of the antenna are connected to corresponding, respective contact pads of said module and of said electronic microcircuit via conductor leads, and wherein an insulator is placed between the microcircuit and at least an antenna zone under the microcircuit.

The invention therefore may provide a basic part of small size which may be used virtually indifferently for the production of contactless cards of usual format or small-sized electronic labels, regardless of their shape.

According to other advantageous characteristics of the electronic module of the invention:

- the antenna may be made up of a spiral whose outer size is in the region of 5 to 15 mm, preferably of about 12 mm, whose ends are connected to contacts of the electronic microcircuit,

- the antenna may be made up of a conductor spiral having between 6 and 50 turns, each turn having a width of approximately 50 to 300  $\mu\text{m}$ , the space between two contiguous turns being of about 50 to 200  $\mu\text{m}$ .

- the spiral forming the antenna may, for example, be of substantially circular outer shape, with an outer diameter of about 5 to 15 mm, preferably of about 12 mm. As variants, said spiral may be of substantially square outer shape, with an outer side measurement of approximately 5 to 15 mm, preferably approximately 12 mm, or of substantially oval outer shape having a larger measurement of approximately 15 mm and a smaller measurement of approximately 5 mm.



the microcircuit may be placed in the centre of the antenna and on the same side of the module as the antenna, the connection terminals of the antenna being connected to respective corresponding contact pads of the module or microcircuit via conductor leads.

5        -        on one face of the carrier substrate the electronic module may comprise an antenna connected to the microcircuit, and on the other face of the carrier substrate it may comprise visible contact pads that are also connected to the microcircuit in such manner as to obtain a hybrid card able to be read and written on via the contacts and/or the antenna.

10       -        a tuning capacitor may be connected in parallel to the terminals of the antenna and of the electronic microcircuit, and its value may be chosen so as to obtain a module operating frequency situated in a range of approximately 1 Mhz to 450 Mhz. In particular, the value of the tuning capacitor may be in the region of 12 to 180 picoFarad, and the operating frequency of the module is  
15       approximately 13.56 Mhz. Alternatively, the value of the tuning capacitor may be in the region of 30 to 500 picoFarad, and the operating frequency of the module may be approximately 8.2 Mhz. This tuning capacitor may be obtained by depositing oxidized silicon on the surface of the microcircuit previously coated with an insulator.

20

According to a further aspect of the present invention there is provided an electronic label suitable for object identification, wherein said label is provided with an electronic module including a carrier substrate for an electronic microcircuit, said electronic microcircuit being connectable to an antenna to  
25       enable contactless operation of the module, the whole of said antenna being arranged on the module and including turns made in the plane of the carrier substrate.

30       According to a still further aspect of the present invention there is provided process for manufacturing an electronic label, said process including the steps of:



- cutting out from a contactless card a first element incorporating an electronic module in accordance with any one of claims 1 to 14, to a given shape so as to leave substance around the module;

- cutting out from a card a second element having the same shape as  
5 said first element; and

- assembling said first and second elements in such manner that said electronic module is incorporated between said elements and protected by the latter.

10 A preferred embodiment of the present invention will now be described with reference to the appended drawings in which:



- figure 1 shows a contactless card of the state of the art ;

- figure 2 shows a contactless card of the invention ;

5       - figure 3 shows a strip used for the continuous manufacture of electronic modules of the invention, intended for use in contactless cards or electronic labels of the invention, and a card intended to house the module ;

10       - figures 4A to 4G show several variants of embodiment of an electronic module of the invention, able or intended to be incorporated into the body of a contactless card or into an electronic label ;

15       - figures 5a to 5D show a section view of several variants of embodiment of an electronic module provided with an antenna, according to the invention, and

- figure 6 shows a section view of a module for a contact and contactless hybrid card.

20       - figure 7 shows the stages of a manufacturing process for a variant of electronic label using the electronic module of the inventions.

Similar parts are given the same reference numbers in all figures.

25       Reference is made to figure 1 showing a diagram and plan of a contactless card 1 having the type of those actually marketed. As can be seen, antenna 2 in the form of a large-sized coil, slightly smaller than the size of the card, is integrated into the card body



3, and two end of the coil of antenna 2 are connected to supply contacts 4, 5 of an electronic module 6 carrying an integrated microcircuit 7 also called a chip.

5           The coil is shown to scale, except in respect of the number of turns, only four turns being shown. To assemble such coil 2 with card body 3, it is required to conduct complex, costly lamination or injection operations with the above-mentioned disadvantages. With  
10 this kind of antenna it is possible to read card information from a distance of 70 mm onwards at a frequency of a few Mhz.

          Unlike the card in figure 1, the general underlying principle of the invention consists of no  
15 longer using the large-sized antennas currently used for contactless cards, in order to overcome the above-mentioned disadvantages. The invention also sets out, in order to reach the desired objectives of reliability and low manufacturing cost, to use certain principles  
20 and the production lines used for the manufacture of contact cards, such manufacture being currently well circumscribed and allowing low manufacturing costs to be obtained.

          A diagram of the solution put forward is shown  
25 by the card 1 in figure 2. It consists of using a particular module 6 of chip card combining on one same small-sized carrier the electronic functions of conventional chip modules, and the function of transmitting/receiving antenna for contactless transmission of information between the card and an  
30 outside reading/writing device (not shown).



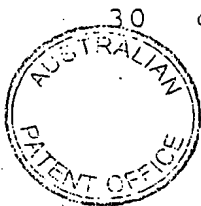


The size of module 6 is compatible with known manufacturing processes used to manufacture contact cards, in its thickness and plane; length and width.

Obviously, for a module provided with an  
5 antenna to be feasible, the size of the antenna obtained must, contrary to the teaching of the state of the art, be compatible with the size of the module, while maintaining a number of turns able to assure  
10 electromagnetic transmission at sufficient distance, in the region of a few centimetres. For this purpose, the antenna is made in the form of a spiral made up of a group of turns lying directly on the carrier substrate and substantially in the same plane, which excludes air  
15 coils as taught by some documents of the prior art mentioned above.

In order to best adapt to the shape of the module and to available surface area, the antenna may have an outer turn of substantially square, rectangular, circular or oval shape or any other  
20 suitable shape. The two ends of the antenna are connected to the supply terminals of an integrated circuit, in particular a memory and/or microprocessor, also positioned on the module as shown under reference 7 in the diagram in figure 2 but shown in more detail  
25 in figures 4 to 6.

With reference to figure 3, illustrating the separation of an electronic module of the invention from a strip 8 comprising a plurality of modules 6 placed for example in two rows. The fabrication of  
30 conventional electronic modules on such strips is well



known as such in the sphere of contact card production and will not therefore be further described.

A module 6 of the invention, for example of the type comprising an integrated circuit 7 « astride » the turns of an antenna 2 in square spiral shape, is detached from strip 8 by a cutting process, for example mechanical cutting. The cut-out module is taken by automated means that are not shown but are known, and is brought preferably with the reverse side facing upwards (integrated circuit and antenna facing the bottom of the opening of the card body) opposite a blind opening 9 made in the card body 3 of a contactless chip card 1. Attachment of module 6 in opening 9 provided is made by gluing, welding or any other appropriate means.

The result is a contactless card according to the invention provided with an antenna 2 positioned at electronic module level 6 and whose fabrication is chiefly limited to the stages which have just been described, followed, obviously, by any usual printing and personalisation stages.

Figures 4A to 4G show in more detail several module variants intended to be integrated into cards for the production of contactless cards, or to be integrated into a support of a different form to the card, for example to manufacture electronic labels.

A module 6 is made up of a conventional carrier substrate 10 (in relatively flexible film, mylar, epoxy or capton) on which is added not a coil but an antenna pattern 2 which may be made in several manners as will



be explained below. Antenna 2 is, for example, made by stamping from a copper sheet followed by assembly of the stamped sheet with the carrier substrate. Carrier substrate 10 and antenna 2 are possibly assembled in  
5 precise manner, using known substrate guiding and positioning means.

Antenna 2 may also be obtained by photochemical etching of the antenna pattern, or by depositing metallic matter on a flexible film forming substrate  
10 10. The choice of a suitable carrier substrate 10 has consequences on the thickness of the module and is chiefly dependent upon the intended use of the module. This choice is fully within the scope of men of the art.

15 In one variant put forward for electronic module 6, antenna 2 is made up of a copper stripe approximately 15  $\mu\text{m}$  to 70  $\mu\text{m}$  thick, made in spiral form, with spaces between the turns of the same size. Ends 11, 12 of this spiral are preferably widened so as  
20 to form contact pads for connection with microcircuit 7.

Provision is made for several variants in the respective positioning of the microcircuit and antenna. Under a first embodiment of the module 6 that is  
25 practical and uses little space (figure 4A) chip 7 is glued in the middle of antenna 2. Figure 4B also shows connecting conductor leads 13, 14 to connect a respective terminal of chip 7 to a corresponding respective end 11, 12 of the antenna. For this purpose a lead 15 needs to be passed above the antenna lines.



For this purpose an insulator 16 is previously deposited, in particular by screen processing between the corresponding stripe zone and connector lead 15.

Under another embodiment of module 6 (figure 4C) antenna 2 takes up the whole side of the module and has no free space in its centre. In this case, the invention provides for gluing microcircuit 7 either onto the module face with no antenna or onto the same face as the antenna (figure 4D), after placing an insulator (dark part 16) between antenna 2 and microcircuit 7.

Figure 4E shows a variant of electronic module 6, in which antenna 2 has a round spiral shape, microcircuit 7 being positioned over the plane of the turns with interpositioning of an insulator 16. With this configuration it is possible to minimize the length of connection leads between the antenna and the microcircuit.

Figure 4F illustrates an additional variant of module 6 of the invention, particularly adapted to cases in which an elongated or rectangular module is required. In this case, the pattern of antenna 2 has a substantially oblong spiral shape, microcircuit is preferably located in the centre of the antenna and the connections between the terminals of the microcircuit and the coil pads are made as described for figure 4B.

It is to be noted that the connection between the chip pads and the contact terminals of the antenna may be made using a conventional connection technique for conductor leads, such as for example so-called



« bonding » consisting of conductor leads welded between a pad of the microcircuit and a respective terminal of the antenna, or using the so-called « flip-chip » technique consisting of adding the microcircuit  
5 onto the module substrate 10 with the face carrying the antenna and microcircuit glued onto the substrate. Resin protection of the contacts is then achieved using conventional processes for producing contact chip cards.

10 Figure 4G gives a more detailed view of an electronic module 6 of the invention, on which a tuning capacitor 17 has been fabricated astride the antenna turns, by depositing on top of insulating layer 16 (shaded part). In order to connect the capacitor in  
15 parallel between terminals 11, 12 of antenna 2 and pads 13, 14 of the microcircuit, a terminal 18 of capacitor 17 is connected to terminal 12 and pad 14, and the other terminal 19 of capacitor 17 is connected to terminal 11 and pad 13 via intermediate pads 20, 21  
20 connected by an intermediate connection 22 located between intermediate pads 20, 21 and made over insulating layer 16 in such manner as not to short-circuit the antenna turns.

Obviously, other provisions of tuning capacitor  
25 17 are possible. In particular, it can be integrated onto microcircuit 17 itself, at the design stage of the latter, which will reduce the number of manufacturing stages of module 6.

The antenna pattern is determined so that it  
30 will allow operation at high frequency, in the Mhz region, the value of tuning capacitor 17 being chosen



to obtain a determined operating frequency of antenna 2 within a high frequency range of approximately 1 Mhz to 450 Mhz. In one example of embodiment, allowing a usual operating frequency of approximately 13.56 Mhz to be  
5 obtained, the value of tuning capacitor 17 is in the region of 12 to 180 picoFarad. In another variant allowing operation at 8.2 Mhz, the value of the tuning capacitor is in the region of 30 to 500 picoFarad.

Figures 5 and 6 show various embodiments of  
10 module 6, shown in section view. In figure 5 a metal grid has been used as an antenna that is cut out and then glued onto carrier substrate 10. Mechanical cutting of a spiral antenna is suitable for stripe widths that are not too fine, currently in the region  
15 of at least 300  $\mu\text{m}$ .

In figure 5A, microcircuit 7 and antenna 2 are situated on the two opposite faces of carrier substrate 10, contact terminals 11, 12 of antenna 2 being connected to pads of the microcircuit (not shown) via  
20 connection leads 15 brought through pits 23 made in carrier 10.

In figure 5B, microcircuit 7 is on the same side as antenna 2 and is deposited over its turns with interpositioning of an insulator 16. In figure 5C,  
25 microcircuit 7 is placed in a cavity 25 made for this purpose in carrier 10 of the module, which allows the thickness of the module unit 6 to be reduced. In figure 5D, microcircuit 7 is simply glued in the centre of antenna 2, as is also shown in figures 4A, 4B. In all  
30 cases, the whole of the antenna is positioned on



carrier substrate 10 forming part of the module, and the microcircuit is added onto this substrate and antenna structure.

It is to be noted that in order to further  
5 reduce the thickness of module 6, it is possible to use for antenna 2, instead of a cut-out metal grid, a grid that is etched in or deposited by metallisation or otherwise on a suitable carrier substrate 10.

Figure 6, which is a top section view of  
10 another embodiment of electronic module 6, in order to obtain a hybrid contact and contactless module, particularly adapted to the manufacture of hybrid cards. In this module, microcircuit 7 and the antenna are placed on a first face of carrier substrate 10 of  
15 the module, as already described in respect of figure 5. Also, contacts 26, identical to contacts for contact cards, are connected to corresponding pads of the microcircuit by conductor leads 27. The microcircuit can communicate with the outside using contacts 26 or  
20 antenna 2 depending upon the outside signal applied. All the effective components for the operation of the hybrid card, including antenna 2, are therefore arranged on a hybrid module 6 of small size, able to be inserted, i.e. to be incorporated into a card body.

25 Advantageously, two modules 6 of the one of the above-described types, may be made side by side in the width of a standard film 10 (i.e. 35 mm), but other arrangements of module 6 on a carrier strip 8 come within the limits of the invention. Each module 6 may  
30 then be transferred onto a card body 3 of standard ISO format using conventional processes for transferring



modules to card bodies, such as used for the production of contact cards.

Alternatively, modules 6 may be used for the production of electronic labels, of the type used for  
5 object identification. If necessary, after being cut from carrier strip 8, modules 6 are protected by a protective resin coating or any other suitable material, allowing small-sized labels to be obtained at low cost. Obviously, the modules may also be integrated  
10 or fixed onto different or more voluminous supports (keys, packaging, etc.) in relation to the intended application.

With reference to figure 7. As an interesting variant of the label manufacturing process, in order to  
15 take advantage of scale savings and production lines for contact cards, while nevertheless using modules 6 of the invention, it is also possible to produce electronic labels using a process which consists solely of the above-described cutting-out stage of electronic  
20 module 6 from a contactless card 1 incorporating such module, in such manner as to leave only some card body substance around electronic module 6 for the purpose of protecting module 6. In this way, from mass-produced contactless cards of the invention it is easy to obtain  
25 electronic labels having the thickness of a card but with much more reliable plane measurements.

In this case, however, a major disadvantage becomes apparent for certain applications : when simply cut out from a contactless card, the label is only  
30 protected on one side by the very minimal protection provided on one side of the cavity by a veil of plastic





matter a hundred or so micrometers thick, whereas the other face of the module is exposed. To remedy this drawback, it is possible in judicious manner, as shown in figure 7(a), to cut out from one part of card 1 which at all events would be discarded, a first part 28 having the size of the planned label format. Then, as shown in figure 7(b), this part 28 is transferred onto the face of the label on which module 6 is visible and non-protected. Part 28 is mounted on card 1 as shown in figure 7(d) using any appropriate technique, in particular by gluing or ultrasound welding. Finally, as shown in figure 7(e) a part 29, is cut out from the same card having the same size and at the same level as part 28. In this way a symmetrical electronic label can be obtained at low cost, of which an enlarged diagram is given in figure 7(f). Obviously parts 28 and 29 could be cut out separately and subsequently assembled.

Such label 30 incorporates a module 6 protected on both sides, and may be graphically personalized on both sides to produce labels that can be used in games or any other applications.

In respect of the performance of the modules, cards and labels of the invention, theoretical and practical results show that on module 6 a performing antenna is obtained able to operate over the frequency range of 1 to 450 Mhz.

In order to obtain required connection performances for a given application, only a sufficiently high modulation frequency needs to be used (for example 13.56 Mhz) to obtain acceptable performances at reading/writing distance.



If, for example, the frequency of 13.56 Mhz is considered, which is frequently used in electronic cash dispensing applications, the performances obtained are fully remarkable. A chip 7 mounted using this process and associated with antenna 2, can currently achieve an operating distance of approximately 50 mm whereas the same chip mounted with a conventional coil of card size can reach approximately 70 to 75 mm. This difference is not critical for most currently considered contactless applications. Also, this performance may be substantially improved by working on transmission circuits and the recovery of electromagnetic energy of the module and outside readers.

According to one practical embodiment, the module size is in the region of 12 mm x 12 mm, but it is possible to consider slightly larger, elongated formats to increase performance, or even optimising the reader antenna or even the chip antenna itself in respect of its consumption to improve performance and attain that of a larger antenna.

With the concept of the invention, if module 6 is used to manufacture cards, card integrity is maintained throughout the entire production process. Consequently, the card body may easily be used in conventional manner to house a magnetic stripe. Also, it may be printed using any existing processes with no particular restraints other than those that are known for the manufacture of a conventional card.

Also, the choice of material for the card body is in no way restricted : it can be adapted to the needs of various applications given consideration.



Consequently, the invention simultaneously solves all the above-described disadvantages connected with the production of contactless modules for contactless cards, in particular in respect of cost,  
5 space requirement, printing, compatibility with embossing or the insertion of a magnetic stripe. The small size of the antenna brings comparable advantages for the production of electronic labels, that are not dependent upon the shape of a card body.

10 The economic advantage of the invention is undeniable ; it enables the same production lines to be used for the production of electronic modules with integrated antennae, and of operational, contactless electronic labels and cards at a fraction of the  
15 current cost of processes used to produce contactless cards or labels, at every stage of their manufacture.

Other subsidiary advantages related to the module, the contactless label and card of the invention and to their manufacturing processes lie in the fact  
20 that no antenna coil handling, no tin welding, no precise positioning of the coil and no printing before insertion are required.



THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. Electronic module suitable for producing contactless cards and/or contactless electronic labels, said module including a carrier substrate for an electronic microcircuit, said electronic microcircuit being connectable to an antenna to enable contactless operation of the module, the whole of said antenna being arranged on the module and including turns made in the plane of the carrier substrate, wherein the microcircuit is placed on the same side as said antenna astride its turns, wherein end terminals of the antenna are connected to corresponding, respective contact pads of said module and of said electronic microcircuit via conductor leads, and wherein an insulator is placed between the microcircuit and at least an antenna zone under the microcircuit.
2. Electronic module in accordance with claim 1, characterized in that said antenna is made up of a spiral whose outer size is in the region of 5 to 15 mm, and whose end terminals are connected to said contact pads of the electronic microcircuit.
3. Electronic module in accordance with claim 2 wherein said outer size is in the region of 12 mm.
4. Electronic module in accordance with claim 2 or 3, characterized in that said antenna is made up of a conductor spiral comprising between approximately 6 and approximately 50 turns, the width of each turn being approximately 50 to 300  $\mu\text{m}$ , the space between two contiguous turns being in the region of 50 to 200  $\mu\text{m}$ .
5. Electronic module in accordance with claim 3, characterized in that the outer shape of said spiral is substantially circular, having an outer diameter in the region of 5 to 15 mm.



6. Electronic module in accordance with claim 5 wherein said outer diameter is approximately 12 mm.
7. Electronic module in accordance with claim 4, characterized in that the  
5 outer shape of said spiral is substantially square, with an outer side measurement in the region of 5 to 15 mm.
8. Electronic module in accordance with claim 7 wherein said outer side measurement is approximately 12 mm.
- 10
9. Electronic module in accordance with claim 4, characterized in that the outer shape of said spiral is substantially oval, having a larger measurement of approximately 15 mm and a smaller measurement of approximately 5 mm.
- 15
10. Electronic module in accordance with any one of the preceding claims, characterized in that a tuning capacitor is connected in parallel to terminals of the antenna to contact pads of the electronic microcircuit, the value of said capacitor being chosen to obtain an operating frequency for said module in the range of approximately 1 Mhz to 450 Mhz.
- 20
11. Electronic module in accordance with claim 10, characterized in that the value of said tuning capacitor is in the region of 12 to 180 picoFarad, and in that the operating frequency of the module is approximately 13.56 Mhz.
- 25
12. Electronic module in accordance with claim 10, characterized in that the value of said tuning capacitor is in the region of 30 to 500 picoFarad, and in that the operating frequency of the module is approximately 8.2 Mhz.
- 30
13. Electronic module in accordance with any one of claims 10 to 12, characterized in that the tuning capacitor is obtained by depositing oxidized silicon on the surface of the microcircuit previously coated with an insulator.



14. Electronic module in accordance with any one of the preceding claims, characterized in that it includes on one face of said carrier an antenna connected to said microcircuit and on the other face of said carrier visible contacts also connected to said microcircuit in such manner as to obtain a hybrid card able to be read and written on via said contacts and/or said antenna.

15. Electronic label suitable for object identification, wherein said label is provided with an electronic module including a carrier substrate for an electronic microcircuit, said electronic microcircuit being connectable to an antenna to enable contactless operation of the module, the whole of said antenna being arranged on the module and including turns made in the plane of the carrier substrate.

16. Electronic label in accordance with claim 15, characterized in that the largest measurement of the electronic module is in the region of 5 to 15 mm.

17. Electronic label, characterized in that it is provided with an electronic module in accordance with any one of claims 1 to 14.

18. Electronic label in accordance with any one of claims 15 to 17, characterized in that the electronic module is provided with its microcircuit and its antenna is fixed on or integrated in a carrier, so that the label may be made part of an object to be identified.

19. Process for manufacturing an electronic label, said process including the steps of:

- cutting out from a contactless card a first element incorporating an electronic module in accordance with any one of claims 1 to 14, to a given shape so as to leave substance around the module;

30 - cutting out from a card a second element having the same shape as said first element; and



- assembling said first and second elements in such manner that said electronic module is incorporated between said elements and protected by the latter.

5 20. Process according to claim 19 wherein said card includes said contactless card.

21. Electronic module suitable for producing contactless cards and/or contactless electronic labels substantially as herein described with reference to  
10 Figs. 2 to 7 of the accompanying drawings.

22. Electronic label suitable for object identification substantially as herein described with reference to Figs. 2 to 7 of the accompanying drawings.

15 23. Process for manufacturing an electronic label substantially as herein described with reference to Figs. 2 to 7 of the accompanying drawings.

DATED: 6 October, 1999

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GEMPLUS SCA



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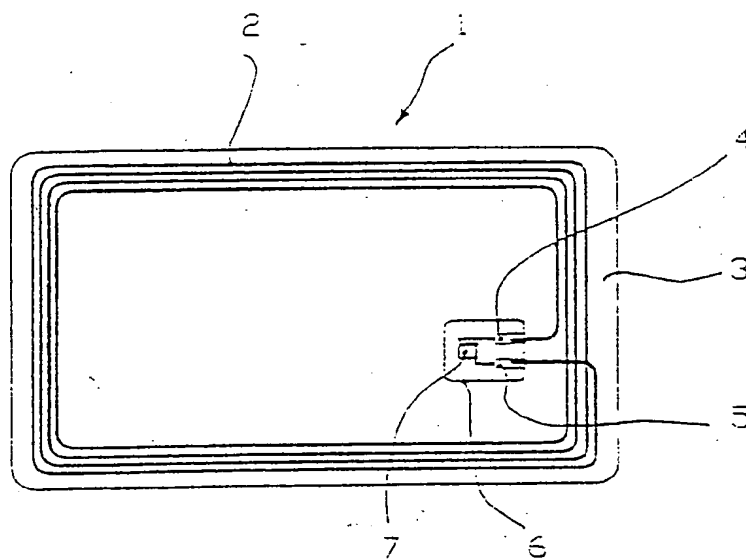


FIG. 1

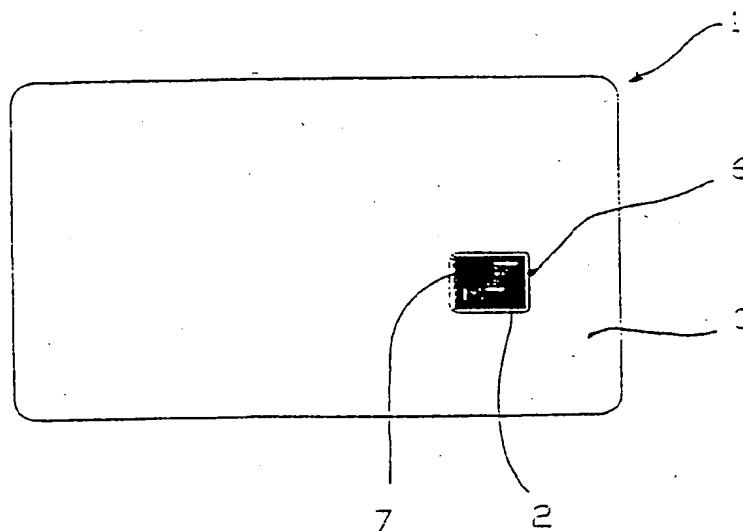


FIG. 2



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FIG.3

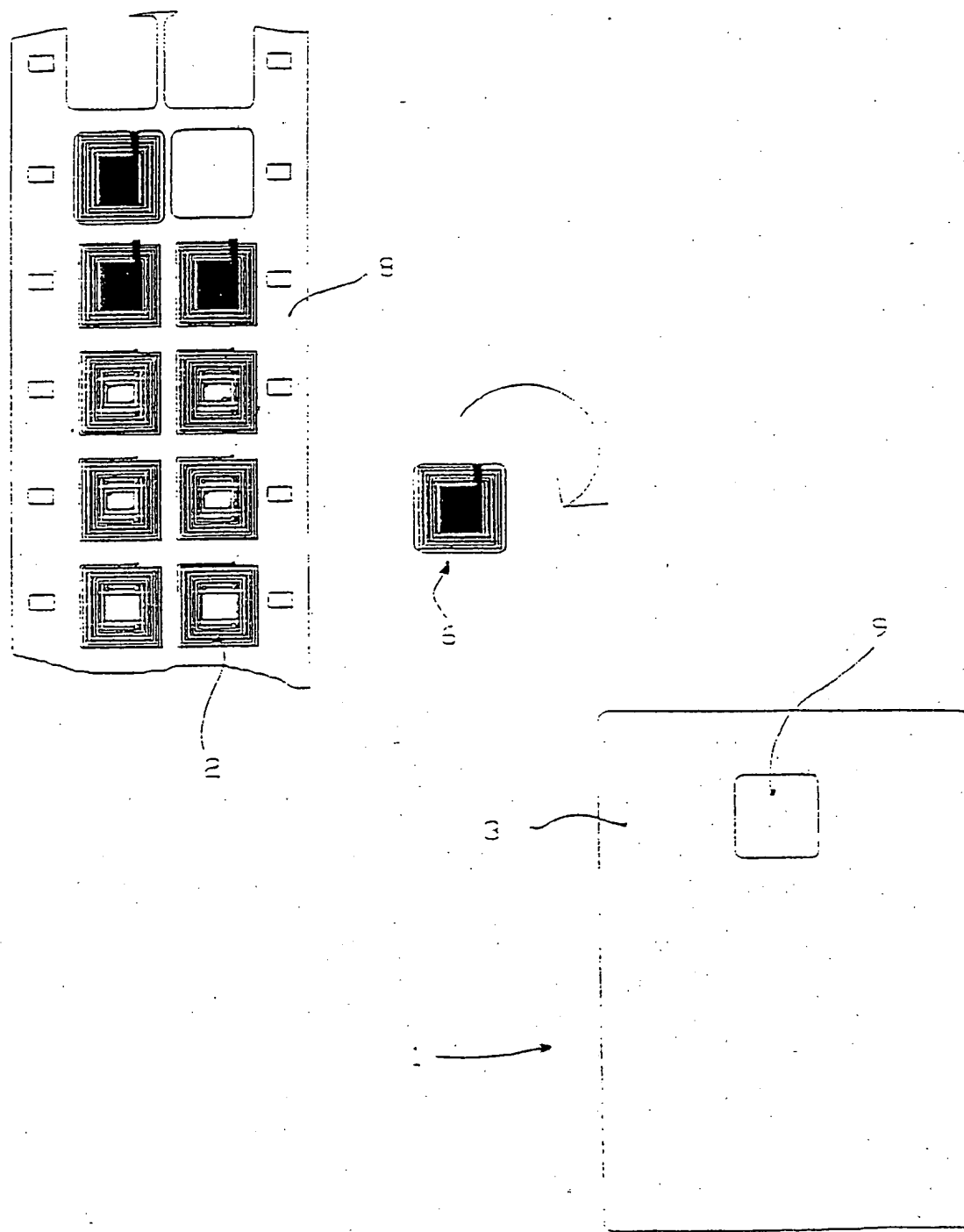


Fig. 4A

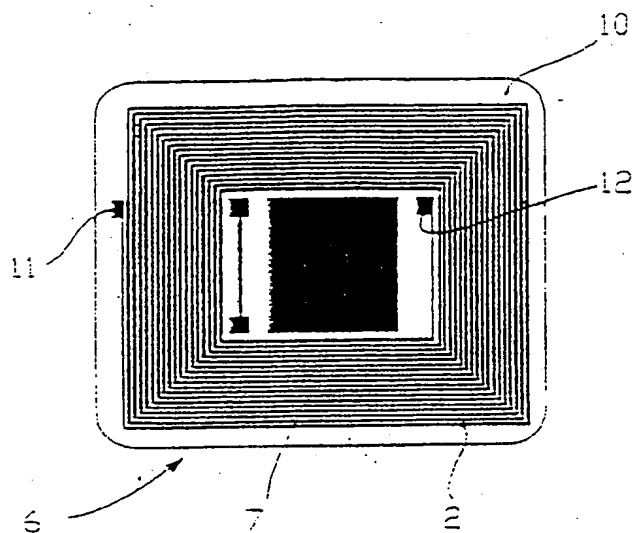


Fig. 4B

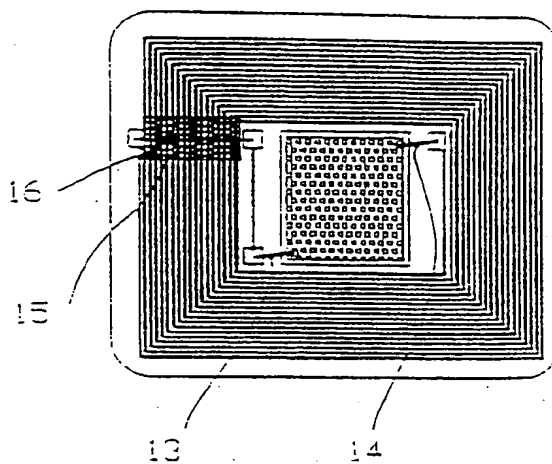


Fig. 4C

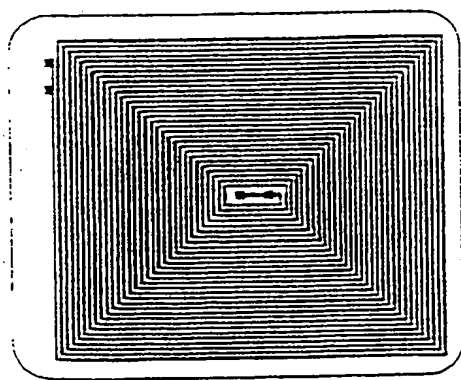


Fig. 4D

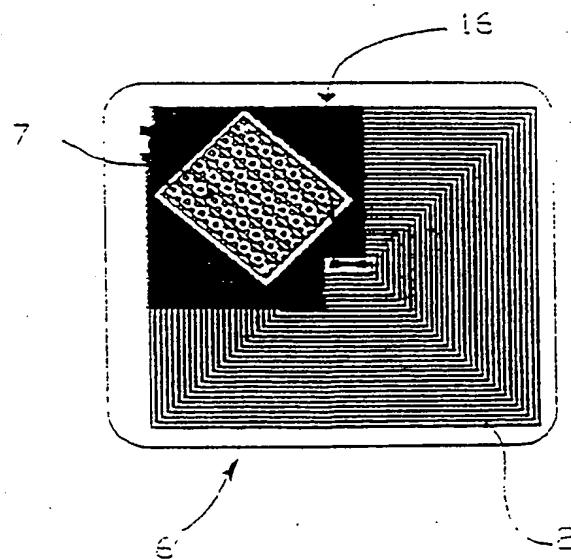


FIG. 4E

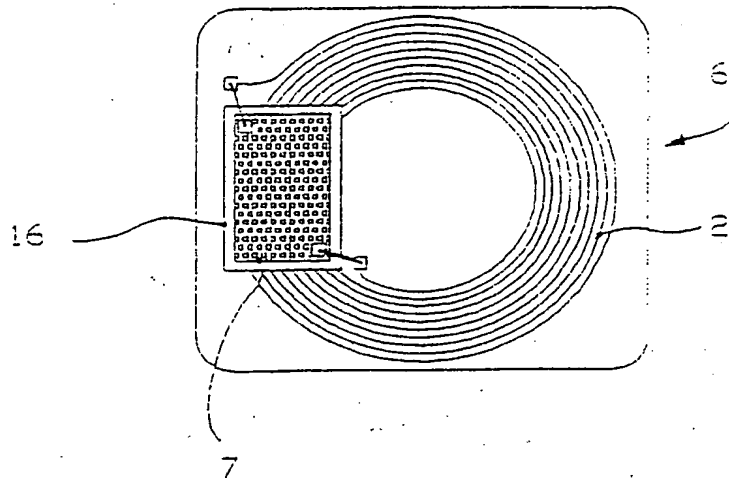


FIG. 4F

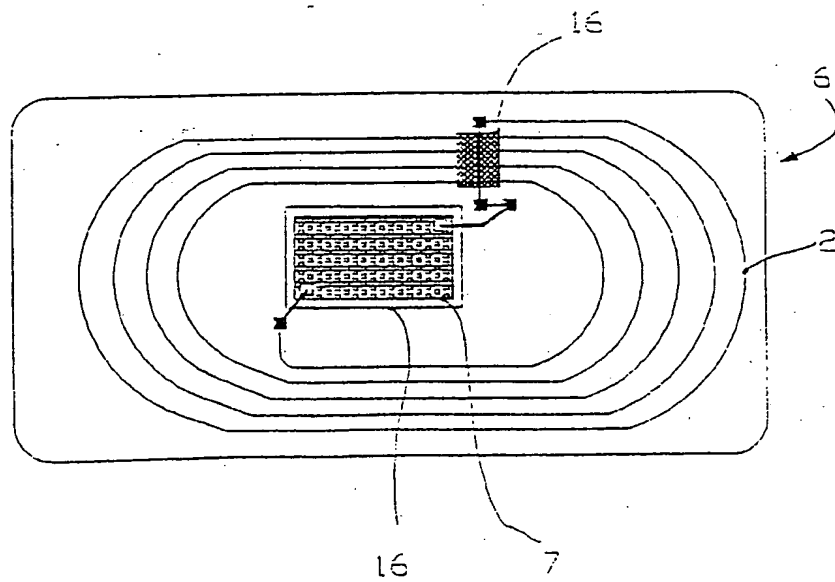


FIG. 4C

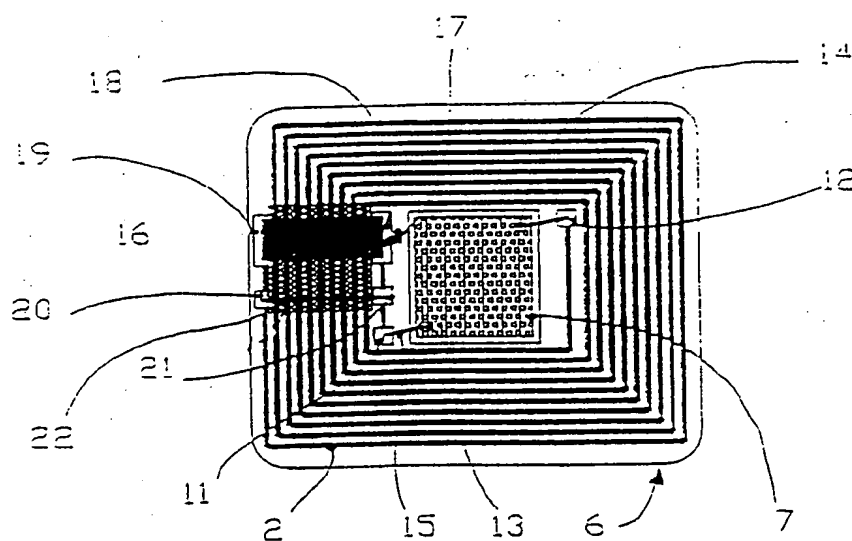


FIG.5

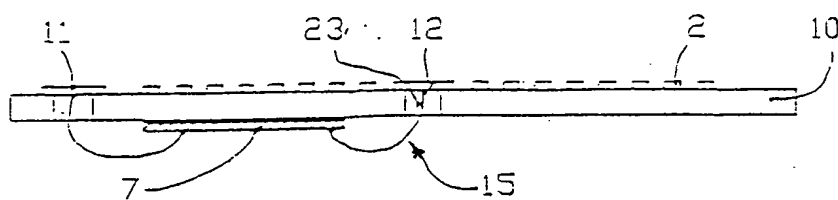


FIG.5A

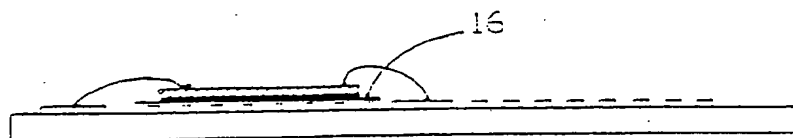


FIG.5B

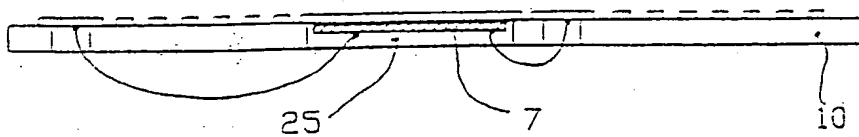


FIG.5C

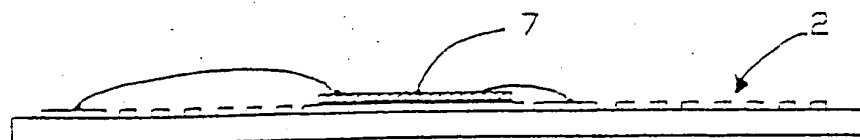


FIG.5D

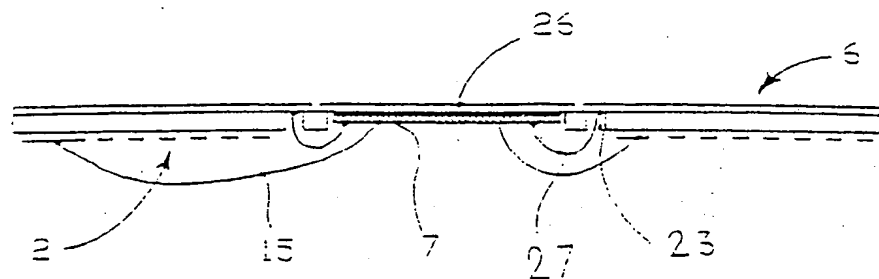


FIG. 6A

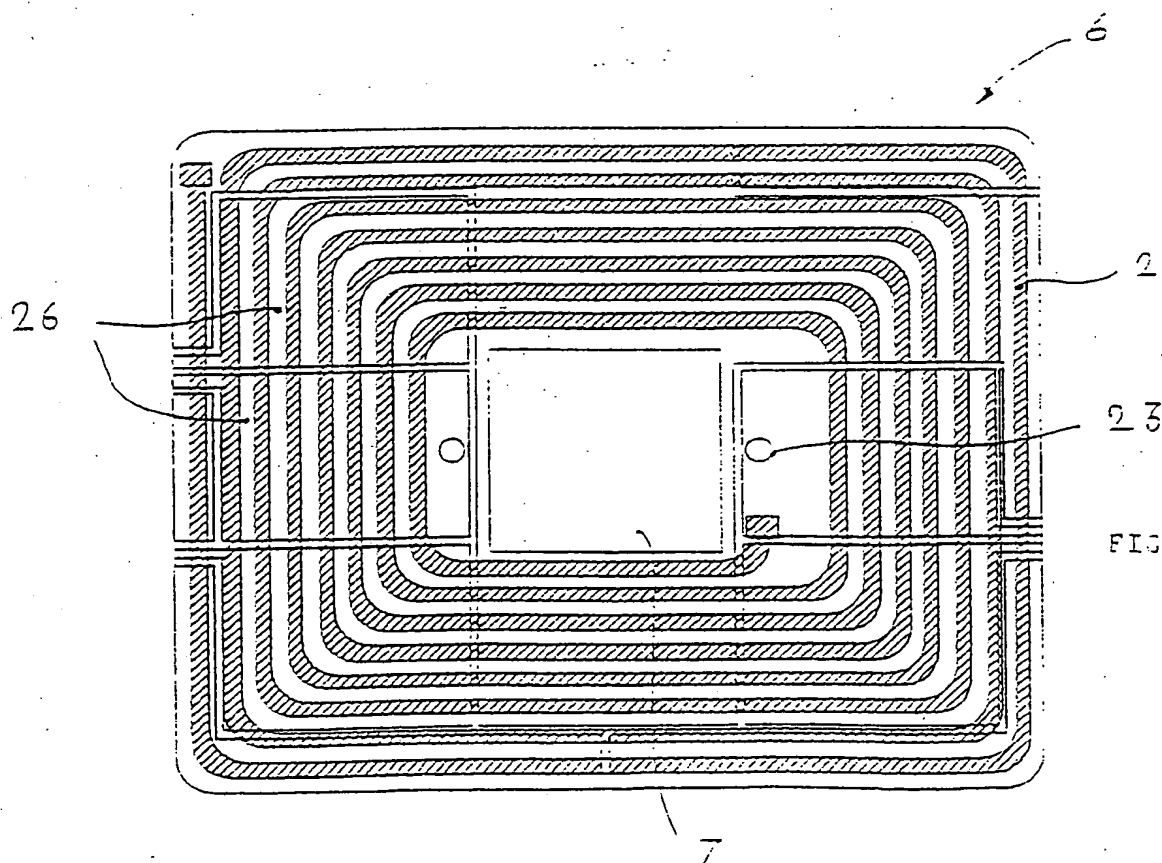


FIG. 6B

FIG. 7

